PHYS 111 (Fall 2020) Honors Mechanics (with Lab)

Time: Mon, Wed & Fri, 9:45–10:40 am
Online Lectures: zoom meeting ID: 968 5473 1042 link, passcode: Principia

Instructor: Mustafa A. Amin
Email: mustafa.a.amin@rice.edu
Skype: mustafa.a.amin
Ph: (832) 938-5826
Virtual Office Hrs: Fri 2:00-3:00 pm (or by appointment)
zoom meeting ID for office hours: 994 9370 9227 link, passcode: Noether

Help Session Teaching Assistant: Eduardo Ibarra Garcia Padilla
Email: eibarragp@rice.edu
Virtual Help Session hrs: Tue and Friday 4:00-5:30 pm (except on Rice Holidays)
zoom meeting ID for office hours: 939 7933 8181 link, passcode: Haytham

Instructor for Laboratories: Prof. Stanley A. Dodds
Email: dodds@rice.edu
Ph: 713-348-2510

Course Format: The course will include lectures, problem sets, exams and labs. Because of the ongoing pandemic, this course will be online, with lectures delivered via zoom and your homeworks and exams will be submitted online. For the lectures, I will typically write on the screen in real-time during the lectures, and expect active participation from the students. The class will be interactive with student-student, and faculty-student interactions through questions, discussions and polls. At times, we will use online resources for demonstrations, talks on current topics relevant to the course, and guided computer simulations to further enrich the course. Along with virtual office hours, and help-sessions every week, I plan to have a short virtual session with each of you at the beginning of the semester. The recorded lectures, and class notes will also be available on canvas.

General Course Information: This 4-credit-hour course covers content similar to PHYS 101, but our textbook and course assume particularly well-prepared and well-motivated students. Such students are encouraged to take PHYS 111, particularly if they might want to major in physics or a closely related field. We will cover some additional material to PHYS 101, and certain topics will be explored in greater depth. There will be more of an emphasis on derivations and on homework, and a somewhat higher workload. If you are considering switching from PHYS 111 to PHYS 101, I strongly recommend deciding as soon a possible; ideally within the first two weeks of the semester.
Prerequisites: A prerequisite for this course is knowledge of differential and integral calculus equivalent to MATH 101 and 102 (as indicated, for example, by a score of 4 or preferably 5 on the AP Calculus BC exam). AP Physics, with or without calculus, is preferred but not required.

Why Study Mechanics? A course in classical mechanics is typically the first course in the undergraduate physics curriculum, and serves as a foundation course for the physics and astronomy majors as well as much of science and engineering. Concepts of classical mechanics in this class include vectors, kinematics (the mathematical description of motion without reference to forces), Newton's laws, dynamics (the mathematical description of motion with reference to forces), energy, momentum, angular momentum, rotational motion, Newtonian gravity, harmonic oscillators, and special relativity. Along the way, your will also learn some multivariable calculus, differential equations, and complex variables, but only at an introductory, physics-based level. I hope that the concepts and techniques that you will learn in this course, and the intuition you will develop here, will likely become an intellectual reservoir for more advanced pursuits in the physical sciences.

Learning Objectives: By the end of the course, you (the student) should be able to do the following:

- Mathematically describe motion in inertial and non-inertial frames in 3 spatial dimensions.
- Understand, and be able to apply Newton's Laws to determine the behavior of point particles, systems of particles and rigid bodies.
- Understand the relevance of conserved quantities like energy, momentum and angular-momentum, and use them to determine the dynamics of physical systems.
- Understand the principles of Special Relativity, and their applications.

Main Text: Kleppner and Kolenkow (K&K), *An Introduction to Mechanics*, second edition, Cambridge University Press (2014). See the Rice Bookstore and/or Amazon.com. As described in the preface of the textbook, this course is "intended for students who seek to understand physics more deeply I than the usual freshman level." This textbook has been used at MIT, the University of Chicago, and Princeton.

Web Page: All course materials including notes, problem sets, links to relevant websites, supplementary material, class updates and announcements will be posted on the PHYS 111 Canvas page. canvas.rice.edu. The recordings on each lecture can also be accessed through the canvas page by navigating to Zoom/Cloud Recordings. It is your responsibility to check the course page regularly for the most recent information concerning the class. To learn more about how to use canvas, see canvas.rice.edu/courses/35925.

Additional Resources: Here are brief descriptions of some relevant books and websites. I will discuss web resources further at appropriate junctures during the course.

- Kittel, Knight, and Ruderman, *Mechanics* (Berkeley Physics Course Vol. 1). This is similar to K&K. It was written in the early 1970s as part of a curriculum development effort by the University of California at Berkeley. It is out of print, but used copies are around, and it's pretty good (though dated in places).
- Feynman, Leighton, and Sands, *The Feynman Lectures on Physics*, Vol. 1. This is the first volume of the famous 3-volume set, derived from Feynman's 1st year physics course at Caltech.

- Serwey and Jewett, *Physics for Scientists and Engineers*. This book has been used for PHYS 101. The book's great strength is a large number of problems with a broad distribution in difficulty. The electricity and magnetism part of this has been used for PHYS 102. can obtain the mechanics and E&M parts of the book separately.

- Halliday, Resnick, and Walker, *Fundamentals of Physics*. Also like Serwey and Jewett. Broad, but not especially deep.

- Landau and Lifshitz, *Mechanics*. This is likely too advanced for this course. However, if you want an economical, yet rigorous presentation of mechanics, this is your book.

Problem Sets: There will be weekly problem sets, usually assigned on Wednesday and due the following Wednesday. These problem sets must be done under the *Honor System*, subject to the following:

- *Collaboration:* I encourage you to discuss the class material with your classmates, the TA and me to gain a deeper understanding of the subject matter. For the problem sets, you should work on each problem independently first ($\geq$ 30 min). When needed, get help about the general idea of how to do the problem (from your classmates, TAs or me) but not the details of the entire calculation. If you collaborate/get help from others, they should be acknowledged in the problem sets along with details of what you collaborated/got help on. The write-up should always be done independently.

- Solutions from previous years must not be consulted.

- *Online Resrouces:* Numerous resources are available for physics-problem-solving help online. These sites can be reasonable tools when seeking additional examples of problems or trying to learn difficult concepts. However, these sites are not permitted for use on the specific problems in the problem sets. (Basically, do not try to find an exact solution for a PHYS 111 problem online.)

- *Submission:* Homework should be turned in via canvas by 5:00 pm on the due date. You can upload a typeset pdf, or a single file of a (properly legible) scans/photographs of your homework pages. Late homework will be penalized 15% per day (or part of a day). All late homework must be labeled with the turn-in time and date. To make a request to excuse the late penalty, email me (mustafa.a.amin@rice.edu) stating the problem set number, the turn-in time and date, and the reason for your request. Such requests should be made a day or more before the due date, unless there are extenuating circumstances.

- *Grading/Return:* Graded homework papers will be returned via Canvas. When I compute final grades, I will drop your lowest homework score.

Working hard on the problems is the best way to learn the material. The textbook provides some worked examples, and I will do some in class, but actually thinking about, setting up, and solving problems yourself is the best way to become proficient. Typically, completion of a problem set involves material from the lectures, the textbook, and the help sessions, and a substantial amount of time and effort. Let me re-iterate, please, do not look at solutions from previous years – as well as being an *Honor Code* violation, you will be less-prepared for future problems (including exam problems!), compared to solving them yourself.

Help Sessions: These will take place weekly for each problem set. The Help sessions will be online. The Help Sessions are an opportunity to get together (at least virtually) with classmates and the Help Session teaching assistant, to work collaboratively to understand the material. The Help Sessions are a bridge between the PHYS 111 lectures (which emphasize basic concepts and important derivations) and the Problem Sets (which emphasize applications of the lecture material and provide practice in solving problems). Some of the problems are designed to be quite challenging, so please take advantage of the Help Sessions. Put another way: **Please, Just Go To The Help Sessions!**

Exams: The two "midterm" exams will be timed take-home exams; they will be made via Canvas during specified exam periods. See the Tentative Schedule on page 4. There is usually a one-week Thursday-to-Wednesday period for taking the exam, excluding Saturday and Sunday, and the exam must be returned via Canvas the same day. The final exam will also be take-home sometime in the final exam period. In all the exams you may use the textbook (K&K) and a formula sheet written by you (which you will also turn in with the exam). You must not collaborate with other students on the exams, or use any non-allowed resources (e.g., the web). Previous years' exams must not be consulted (unless I make them available on the course website).

Laboratories: Laboratory work is an integral part of PHYS 111, intended to reinforce the abstract concepts discussed in lecture and to develop data analysis skills. For this semester, all lab exercises will be conducted online. Further details will be available on Canvas by the start of the semester. Questions and comments about the labs should be directed to Professor Dodds.

Make-ups: Make-ups for missed problem sets, exams, or laboratories will be at the discretion of the appropriate instructor (Professor Amin for problems sets and exams; Professor Dodds for labs). If you have university business or a conflicting class, notify us well beforehand, by email. If you have a serious reason beyond your control (for example: your own illness, or a death in the family), notify an instructor as soon as possible by email.

Class Attendance: I strongly encourage you to attend all the lectures. At times I will cover material in the lectures that are not in the book. Moreover, I might use your class participation as a guide when you are on a grade boundary to move you to a better/worse grade. Occasionally, missing a lecture might be unavoidable due to extenuating circumstances. That is ok. Please get notes from canvas and discuss with your class-mates for that missed lecture to make sure you are caught up.

Grading:
Exam 1: 20%
Exam 2: 20%
Final: 25%
Problem Sets: 25%
Labs: 10%

While the scale is not completely fixed, I expect the correspondence between your percentage points for the entire course and your letter grade to be as follows: 95+ = A+; 90+ to 95 =A; 85+ to 90=A-; 80+ to 85 = B+; 75+ to 80 = B, etc. As mentioned above, when I compute final grades, I will drop your lowest homework score. The final grade for the course will include some discretion based on class participation/interactions etc.

K&K Reading: The weekly K&K Reading/Working (which means self-guided reading, summarizing, and working the equations and examples in K&K) is very important. Except for day 1 of week 1, you are expected to complete the K&K Reading/Working for each week, before that week begins; when I cover those topics in lectures, I will assume you have read the relevant sections in the textbook. Note that, in some relatively rare cases, material in K&K may appear in the Problem Sets and Exams, even if it has not been covered in lectures.

Workload: Plan to work, on average, approximately 3 hours per week per credit hour on the course, outside lectures, including the labs. That is, $3 \times 4 = 12$ hours per week for PHYS 111. (This "3 hours of work per credit hour per week" is a good rule-of-thumb for planning your time for other courses too.)

Students with Disabilities: Any student with a documented disability seeking academic adjustments or accommodations is requested to speak with the instructor during the first two weeks of class. All such discussions will remain as confidential as possible. Students with disabilities are encouraged to also contact Disability Support Services in the Allen Center (e-mail: adarice@rice.edu, phone: 713-348-5841) during the first two weeks of class so that timely and appropriate arrangements may be made.

Tentative Course Outline: The weekly coverage might change depending on progress of the class.

Week	Content	K&K Reading	PSets/Exams
Week 1	• orientation, units, vectors, co-ordinates	1.1–1.11, 2.7,2.8	
Week 2	• kinematics, Newton's laws, inertial frames	2.1–2.6, 2.9, 2.10	PS 1 due
Week 3	• constant force, centripetal force, ropes	3.1–3.4	PS 2 due
Week 4	• pulleys, drag, springs, gravity, momentum	3.5–3.7	PS 3 due
Week 5	• N particle systems, center of mass, rockets	4.1–4.10	PS 4 due
Week 6	• pseudo-forces, rotating frames	9.1–9.5	Exam 1 due
Week 7	• Coriolis force, conservation of energy	5.1–5.8, 5.10, 5.11	PS 5 due
Week 8	• energy diagrams, stability, and collisions	6.1–6.3, 6.5	PS 6 due
Week 9	• rotational motion, angular momentum	7.1–7.6	PS 7 due
Week 10	• rigid body motion	7.7, 7.8, 8.1–8.6	PS 8 due
Week 11	• central force motion	10.1–10.6, 11.1,11.2	Exam 2 due
Week 12	• harmonic oscillators, Special Relativity	11.3–11.6, 12.1–12.4	PS 9 due
Week 13	• Special Relativity+wrapup	12.5–12.11	PS 10 due
Week 14	• Thanksgiving		
Week 15			PS 11 due
Week 16/17			Final Exam